

THE SPECIES OF *ANASTREPHA* (DIPTERA: TEPHRITIDAE)
WITH A *GRANDIS*-TYPE WING PATTERN

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Abstract.—A diagnostic key, illustrations, and descriptions are provided for *grandis* (Macquart) and the five other species of *Anastrepha* with similar wing patterns: *atrigena* Hendel, *bezzii* Lima (= *balloui* Stone, n. syn.), *castilloi*, n. sp., *grandicula*, n. sp., and *shannoni* Stone. Phylogenetic relationships among these species are discussed. *Anastrepha bezzii* is removed from the *grandis* species group, and *bivittata* (Macquart) and *fumipennis* Lima are tentatively included. A lectotype is designated for *grandis*. The egg of *shannoni* is briefly described. Host plant and distribution data are summarized.

Key Words: *Anastrepha*, *grandis*, descriptions, phylogeny

Resumen.—En este trabajo se presenta una clave, descripciones e ilustraciones de *grandis* (Macquart) y otras cinco especies de *Anastrepha* con patrones de coloración alar semejantes: *atrigena* Hendel, *bezzii* Lima (= *balloui* Stone, syn. n.), *castilloi*, sp. n., *grandicula*, sp. n., y *shannoni* Stone. Relaciones filogenéticas entre estas especies son discutidas. *Anastrepha bezzii* se transfiere del grupo de especies “*grandis*”, y *bivittata* (Macquart) y *fumipennis* Lima se incluyen tentativamente. Se designa un lectotipo de *grandis*. El huevo de *shannoni* se describe brevemente. Los datos de plantas de alimentación y de distribución son presentados.

Anastrepha grandis (Macquart) is a pest of the fruits of various native and introduced species of Cucurbitaceae in many areas of South America (Norrbom and Kim 1988b). It has recently received considerable attention in regard to the extent to which it attacks honeydew, a type of melon (*Cucumis melo* L.) that is grown commercially in a number of Latin American countries (Harper 1987). In this paper, I describe two new species of *Anastrepha* with wing patterns similar to *grandis*, and that might be confused with it. I also discuss the relationships among these species and those that Steyskal (1977) placed in the *grandis* species group.

MATERIALS AND METHODS

I follow the morphological terminology of McAlpine (1981) and White (1988), except as noted in Norrbom and Kim (1988a). Acronyms for institutions used in the text are as follows: AMNH—American Museum of Natural History, New York; BMNH—British Museum (Natural History), London; CNC—Canadian National Collection, Ottawa; CMP—Carnegie Museum of Natural History, Pittsburgh; CUI—Cornell University, Ithaca; FMNH—Field Museum of Natural History, Chicago; FSCA—Florida State Collection of Arthropods, Gainesville; DEI—Institut für Pflanzenschutzforschung der Akademie der Landwirtschaftswissenschaften

ten, Eberswalde; ICA—Instituto Colombiano Agropecuario, Palmira and Medellín; INPA—Instituto Nacional de Pesquisas da Amazonia, Manaus; INTA—Instituto Nacional de Tecnología Agropecuaria, Concordia; LACM—Los Angeles County Museum of Natural History; MCZ—Museum of Comparative Zoology, Harvard University, Cambridge; NMW—Naturhistorisches Museum Wien; PAN—Polish Academy of Sciences, Warsaw; PMMT—Programa Mosca del Mediterraneo, Sanidad Vegetal, SARH, Tapachula, Mexico; SMT—Staatliches Museum für Tierkunde, Dresden; TMB—Termesztudományi Múzeum, Budapest; UCV—Universidad Central de Venezuela, Maracay; UCRSJ—Universidad de Costa Rica, San José; UMO—University Museum, Oxford; USNM—National Museum of Natural History, Smithsonian Institution, Washington, D.C.; USU—Utah State University, Logan; WSU—Washington State University; ZIL—Zoological Institute, University of Lund.

The dendrogram (Fig. 1) showing the possible phylogenetic relationships among the species in the *grandis* group has not been rigorously tested. Some of the characters used are highly variable within *Anastrepha* and resolution of their polarity within the *grandis* group will require a thorough cladistic analysis of the entire genus. An admittedly subjective hypothesis is presented here, which may be useful until a more comprehensive analysis can be completed.

DIAGNOSIS AND RELATIONSHIPS OF THE *GRANDIS* GROUP

Steyskal (1977) defined the *grandis* species group in one of the couplets of his updated version of Stone's (1942) key to the species of *Anastrepha*. He included those species that have what might be termed the "grandis-type" wing pattern. In this pattern 1) cell r_1 is entirely infuscated, lacking the normal marginal hyaline spot or band immediately apical to the apex of vein R_1 , 2) the S-band is complete, and 3) only the

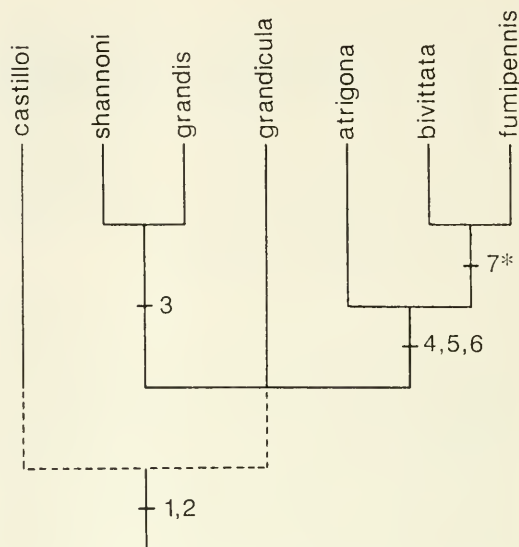


Fig. 1. Possible phylogenetic relationships among the species of the *grandis* group. The following are possible synapomorphies: 1) cell r_1 without marginal hyaline spot (note homoplasy in #7); 2) body color relatively dark; 3) cell r_{2+3} entirely infuscated; 4) cell bm at least weakly infuscated; 5) second section of vein M more than 2.9 times as long as third section; 6) aculeus tip broadly rounded; 7) cell r_1 with marginal hyaline spot (reversal of #1).

proximal arm of the V-band is present. In some specimens of *grandis*, the infuscation at the base of the marginal part of cell r_1 is faint, but there is never a distinctly bordered band or triangular hyaline spot as in most species of *Anastrepha*. A number of *Anastrepha* species might be confused with species with the *grandis*-type pattern because they also lack the hyaline spot in r_1 . Most of the species of the *daciformis* group lack this r_1 spot, but they differ in having the S-band interrupted in cell dm , in having the basal half of the scutellum darker than the apex, and in a number of genitalic characters. Some specimens of *cordata* Aldrich also lack the r_1 spot, but these have a complete V-band with the proximal arm blackish and broadly expanded.

Six species of *Anastrepha* have the *grandis*-type wing pattern. The keys of Stone (1942) and Steyskal (1977) include *grandis*,

atrigena Hendel, *shannoni* Stone, and *bezzii* Lima, as well as *balloui* Stone, here considered a synonym of *bezzii*. Two new species, *castilloi* Norrbom and *grandicula* Norrbom, also have this pattern. Despite the similarity of their wing patterns, the monophyly of these six species is doubtful. *Anastrepha bezzii* is probably more closely related to species such as *mucronota* Stone, *crebra* Stone, and a number of others that have the endophallic sclerite of the distiphallus narrowed and not distinctly convoluted (Fig. 8A, B). The plesiomorphic shape of this sclerite (occurring in *Toxotrypana* Gerstaecker and most other *Anastrepha*) is broad, with a distinct internal tube (Fig. 8C–E). The undulation of vein R_{2+3} is another apomorphic character found in many of these species, although it is frequently variable intraspecifically as in *bezzii*. Although connected in cell r_1 , the separation of the C- and S-bands along vein R_{4+5} in *bezzii* is another similarity shared with these species, which usually have the bands completely separated. The connection of the C- and S-bands is a highly variable character in *Anastrepha*, one that has certainly been affected by homoplasy, but it is noteworthy that in the other species with the *grandis*-type wing pattern, these bands are connected along R_{4+5} . Like *mucronota*, *crebra*, and related species, *bezzii* also retains the plesiomorphic absence of lateral creases on the proctiger (Fig. 7C). They are present (Figs. 7E, 11A) in the other species with the *grandis*-type wing pattern as in the majority of *Anastrepha* species. The shape of the aculeus tip, the elongate pattern of dorsal scales on the eversible membrane, and the weakly sclerotized spermathecae, although distinctive in *bezzii*, are autapomorphic and indicate little about its relationships. One character that contradicts the hypothesis of its relationship to *mucronota* and related species is the posterior orbital seta, which is absent in *bezzii* and sometimes weak or absent in *grandis*, *shannoni*, and *grandicula*. The variability of this char-

acter in the latter three species and the distribution of the other character states discussed above suggest that this is the result of homoplasy, however, like the similarity in wing pattern. On this basis I transferred *bezzii* from the *grandis* group to the *mucronota* group (Norrbom and Kim 1988b).

Anastrepha grandis, *shannoni*, *grandicula*, and *atrigena* are probably closely related, although their monophyly is difficult to clearly demonstrate. Except for the shape of the aculeus tip, their female and male terminalia are very similar, as is their coloration. The absence of the hyaline spot from r_1 and the basal part of r_{2+3} and the absence of the apical arm of the V-band are probable synapomorphies, although neither of these character states (especially the latter) is unique to these species within *Anastrepha*. A monophyletic group including them should possibly also include two poorly known species, *fumipennis* Lima and *bivittata* (Macquart), which I have not examined. *Anastrepha fumipennis* is known only from two females from Rio de Janeiro (Lima 1934) and a third from Espirito Santo (R. A. Zucchi, pers. comm.), whereas *bivittata* is currently unrecognized because the type material, from an unknown locality, has not been located (I did not find it in the UMO or the Museum National d'Histoire Naturelle, Paris). From Macquart's (1843) description it appears to be closely related to or perhaps even conspecific with *fumipennis*, although Lima (1934) noted that the terminalia are shorter in *fumipennis* than is shown in Macquart's illustration of *bivittata*. The scutal color pattern may also differentiate the two taxa, although neither author thoroughly described this character. Both *fumipennis* and *bivittata* have a marginal hyaline spot in cell r_1 , but their wings otherwise closely resemble *atrigena*; cell bm is infuscated, the apical arm of the V-band is absent, the proximal arm is close to the S-band in cell dm (at least in *fumipennis*), the pattern is brown, and the ratio of the second and third sections of vein M is great-

er than 2.9. The aculeus tip in *fumipennis* is also almost identical to that of *atrigena* (its shape is unknown in *bivittata*). Except perhaps for the wing pattern color, these are all probable synapomorphies. One possible hypothesis of relationship among these three species and *grandis*, *grandicula*, and *shannoni* to explain these character state distributions is that the loss of the r_1 hyaline spot is a synapomorphy for the entire group, but it reappeared due to reversal in *fumipennis* and *bivittata* (Fig. 1). A more thorough study of the latter two species is needed to better understand their relationships.

The relationship of *castilloi* to the other species with the *grandis*-type wing pattern is less certain. The presence of the proctiger creases indicates that it is not closely related to *bezzii*, but this is a synapomorphy shared with many *Anastrepha* species. The wing pattern (absence of r_1 hyaline spot and apical arm of V-band) and generally dark coloration may be synapomorphies with the rest of the *grandis* group, but the much different shape of the surstylus, the pattern of dorsal scales on the eversible membrane, and the scutal color pattern suggest that the similarities in wing pattern could be the result of convergence. The latter three character states might also be autapomorphic for *castilloi*, however.

KEY TO THE SPECIES OF
ANASTREPHA WITH THE
GRANDIS-TYPE WING PATTERN

The following key may be used in place of couplets 2-5 in the key of Stone (1942) or in place of that on page 7 in Steyskal (1977).

- 1. Wing (Fig. 2A, B) with a hyaline area in cell r_{2+3} between crossveins bm-cu and r-m; section of vein M between bm-cu and r-m less than 1.85 times as long as section between r-m and dm-cu; vein R_{2+3} usually undulant . . . *bezzii* Lima
- Wing (Fig. 2C-G) with cell r_{2+3} entirely infuscated basal to r-m; section of vein M between bm-cu and r-m more than 1.85 times as long as section between r-m and dm-cu; vein R_{2+3} almost straight 2

- 2. Cell r_{2+3} entirely infuscated (Fig. 2E, G); thoracic pleura with well differentiated yellowish and reddish areas or mostly yellowish with brownish medial spot on anepimeron 3
- Cell r_{2+3} (Fig. 2C-D, F) with large subapical hyaline area; thoracic pleura without well differentiated dark areas except sometimes on greater ampulla, laterotergite, or metapleuron 4
- 3. Abdomen with medial yellowish stripe; cell br (Fig. 2G) entirely infuscated; dark areas of scutum more or less evenly reddish (similar to Fig. 3A); sytergosternite 7 less than 4.0 mm long; aculeus tip (Fig. 13G) serrate, with pair of dorsal lobes; surstylus (Fig. 11C) elongate, slightly acute; aedeagus less than 5.0 mm long *shannoni* Stone
- Abdomen entirely yellowish or orange; cell br (Fig. 2E) with large hyaline area apical to bm-cu; scutum (Fig. 3C) with irregular brown stripe, darker than orange or reddish areas, slightly lateral to dorsocentral seta; sytergosternite 7 more than 4.75 mm long; aculeus tip (Fig. 13E, F) non-serrate, slender, with dorsal and ventral ridges; surstylus (Fig. 11B) moderately long, blunt; aedeagus more than 6.0 mm long *grandis* (Macquart)
- 4. Wing (Fig. 2C) with section of vein M between bm-cu and r-m more than 2.8 times as long as section between r-m and dm-cu; cell bm infuscated, at least weakly; proximal arm of V-band narrowly separated from or partially fused with S-band in cell dm; aculeus tip (Fig. 13A) non-serrate, at least 0.12 mm wide *atrigena* Hendel
- Wing (Fig. 2D, F) with section of vein M between bm-cu and r-m less than 2.5 times as long as section between r-m and dm-cu; cell bm hyaline; proximal arm of V-band separated from S-band in cell dm by hyaline area at least as wide as arm of V-band; aculeus tip serrate or less than 0.07 mm wide 5
- 5. Greater ampulla with distinct dark brown spot; scutum (Fig. 3B) with medial yellowish stripe broadly expanded posteriorly, fusing with narrow stripe in line with dorsocentral seta; sytergosternite 7 greater than 4.0 mm long; eversible membrane with single row of large dorsal scales (Fig. 10C); aculeus tip (Fig. 13C) non-serrate, less than 0.07 mm wide *castilloi* Norrbom, n. sp.
- Greater ampulla yellowish; scutum similar to Fig. 3A, with medial yellowish stripe narrow posteriorly, not extending laterally beyond acrostichal seta, narrow stripes in line with dorsocentral seta absent; sytergosternite 7 less than 4.0 mm long; eversible membrane with

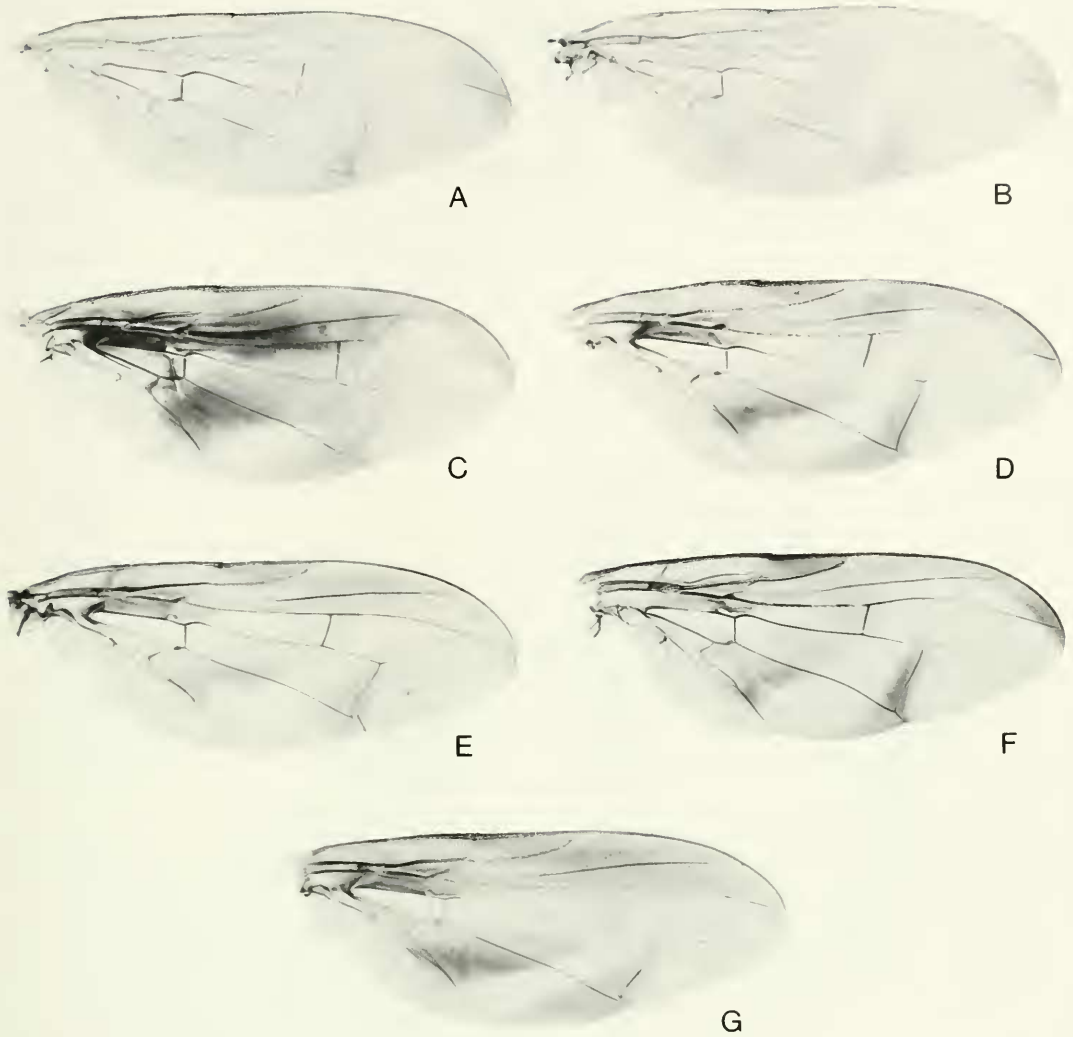


Fig. 2. Wing. A, *A. bezzii*, male. B, *A. bezzii*, female. C, *A. atrigona*. D, *A. grandicula*. E, *A. grandis*. F, *A. castilloi*. G, *A. shannoni*.

numerous large scales in triangular pattern (Fig. 10D); aculeus tip (Fig. 13D) serrate, approximately 0.14 mm wide *grandicula* Norrbom, n. sp.

Anastrepha atrigona Hendel

(Figs. 2C, 3A, 4, 7A, B, 10A, 13A, 14A)

Anastrepha atrigona Hendel 1914a: 70 (Surinam), 1914b: 15 (in key, catalog), 20 (description again as n. sp.); Lima 1934: 499, 555 (in key); Greene 1934: 132, 138 (in keys), 146 (Brazil); Stone 1942: 12 (in key), 21 (♀ terminalia; Brazil); Fernandez

1953: 12 (in key), 18 (Venezuela); Foote 1967: 7 (in catalog); Steyskal 1977: 7 (in key); Zucchi 1978: 17 (in key), 27; Caraballo 1981: 30 (in key), 44 (Venezuela).

Type data.—Holotype ♂ (NMW), “aus Surinam, Firma Staudinger & Bang-Haas.” It bears a label with “Surinam V.-IX.,” a label with “*Anastrepha atrigona* H. det. Hendel” in Hendel’s writing, and a red “Type” label. I have added a holotype label. Hendel apparently removed the right wing for illustration and it may be lost. I have

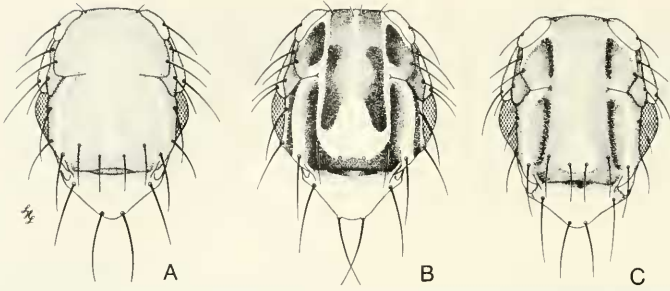


Fig. 3. Mesonotal color patterns. A, *A. atrigona*. B, *A. castilloi*. C, *A. grandis*.



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Fig. 4. Distributions of *A. atrigona* (dots = examined specimens; squares = literature records) and *A. fumipennis* (triangles).

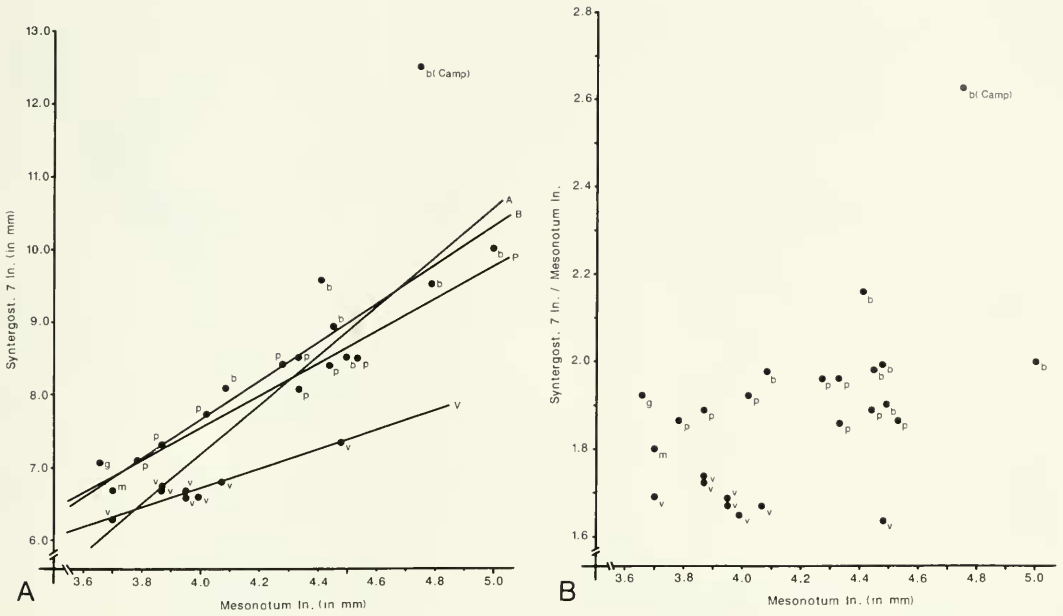


Fig. 5. *A. bezzii*: A, Syntergosternite 7 length (in mm) versus mesonotum length (in mm); B, Relative syntergosternite 7 length (syntergosternite 7 length/mesonotum length) versus mesonotum length. For data points, b = specimens from Brazil, g = Guatemala, m = Mexico, p = Panama, v = Venezuela. Line A = correlation based all specimens (except Campinas ♀, see text), line B = correlation for specimens from Viçosa, Brazil only, line P = correlation based on specimens from Mexico-Panama only, and line V = correlation for specimens from Venezuela only.

dissected the abdomen which is now stored in a microvial.

Description.—Mostly orange to red-brown. Setae dark redbrown to black. **Head:** Concolorous except dark brown ocellar tubercle; 4–5 frontal setae; 2 orbital setae, posterior one always strong. Antenna extends 0.70–0.78 distance to lower facial margin. **Thorax:** Mesonotum (Fig. 3A) 3.30–4.08 mm long. Scutum entirely microtrichose; mostly orange to dark redbrown; single distinct yellowish medial stripe from anterior margin to slightly posterior to acrostichal seta, slightly expanded posteriorly but usually not extending laterally beyond acrostichal seta; no narrow yellowish stripe in line with dorsocentral seta; rarely with poorly differentiated brown stripe slightly lateral to dorsocentral seta, but never as dark as in *grandis*; distinct yellowish sublateral stripe from transverse suture to posterior margin, crossing intra-alar seta; scuto-scu-

tellar suture rarely with irregular dark brown medial spot. Subscutellum and mediotergite redbrown, broadly dark brown laterally. Pleura with typical dark areas at most weakly differentiated. Katepisternal seta undifferentiated or weak, yellowish, no longer than postocellar seta. **Wing** (Fig. 2C): Length 7.50–9.22 mm. Vein R_{2+3} almost straight. Vein M strongly curved apically; section between bm-cu and r-m 2.91–3.43 times as long as section between r-m and dm-cu. Pattern dark orange brown to dark brown, its margins distinct. Cell r_{2+3} with large sub-apical hyaline area; entirely infuscated basally. Cell br and base of cell dm entirely infuscated or with small hyaline area; if present in br just apical to bm-cu, this spot does not reach vein R_{4+5} and extends no more than half way to dm-cu. Cell bm infuscated, often darkly, but sometimes only faintly yellowish. Proximal arm of V-band extends anteriorly to R_{4+5} ; fused to S-band

at R_{4+5} and often also in cell dm. *Abdomen*: Tergites unicolorous orange to redbrown. *Male terminalia*: Outer surstylus (Fig. 7A, B) broad basally, tapering apically to narrow lobe; moderately long, section apical to apex of inner surstylus 1.20–1.70 times as long as basal part; in lateral view similar to *grandis*. Proctiger with distinct lateral fold; sclerotized part narrowly divided into 3 sections. Aedeagus 5.10–5.76 mm long; 1.38–1.49 times as long as mesonotum. Distiphallus 0.58–0.63 mm long, relatively stout; endophallic sclerite similar to *grandis*, strong, stout and distinctly convoluted apically. *Female terminalia*: Syntergosternite 7 3.70–4.45 mm long; 1.08–1.18 times as long as mesonotum. Eversible membrane (Fig. 10A) with dorsobasal scales in triangular pattern; 10–11 large hooklike scales in broadest row; largest scales 0.20 mm long. Aculeus 3.55–4.40 mm long; tip (Fig. 13A) 0.37–0.42 mm long, 0.13–0.14 mm wide, non-serrate, sides broadly convex. Spermathecae (Fig. 14A) ovoid to elongate ovoid.

Distribution (Fig. 4).—Probably throughout the humid forests of Amazonia, the Guianas, and Venezuela. The exact locality within Surinam where the holotype was collected is unknown. It is represented on the distribution map by a dot in the center of the country. I examined four specimens with labels with “4385” and “Dem.,” one of which also has a label with “Demerara, Africa.” I am assuming that this is a mistake and that the site is the Demerara River in Guyana. No species of *Anastrepha* are known to be established in Africa.

The distribution of *atrigona* appears disjunct from that of its possible sister species, *fumipennis* (and/or *bivittata*), from southern Brazil (Fig. 4). It overlaps that of *grandis* only in northern Venezuela.

Specimens examined.—Holotype (see Type data). BRAZIL: Amazon., H. W. Bates, 1 ♀ (BMNH). Amazonas: Amazon River, Atary to Manaus, 20–21.IX.1930, Holt, Blake & Agostini, 1 ♀ (USNM); 1 km E Campinas field station, Km 60 N Manaus,

22.II.1979, T. E. Erwin, 1 ♂ (INPA) 1 ♂ (USNM); Manaus, Campus Univ., various dates, II, XI–XII.1975–1978, J. A. Rafael, 1 ♂ 2 ♀ (INPA) 1 ♂ 1 ♀ (USNM); Manaus, 2.VII.1986, 22.VIII.1985, B. Klein, 1 ♀ (INPA) 1 ♀ (USNM). Pará: Santarem, H. W. Bates, 1 ♂ 1 ♀ (BMNH); Santarem, 1 ♀ (CMP); Santarem, IX, 1 ♀ (USNM); Obidos, 1 ♂ (AMNH); Dampfer [steamer] Prainha—Mte. Alegre, 30.V.1927, Zerny, 1 ♀ (NMW) 1 ♀ (USNM). Rio Branco: Mt. Roraima, 1932, J. G. Myers, 1 ♂ (MCZ) 1 ♀ (USNM). GUYANA: “Demerara, Africa, 4385,” O. S. Westcott, 2 ♂ (INHS) 1 ♂ 1 ♀ (USNM). VENEZUELA: Amazonas: Cerro Duida, 6.III.1929, 1 ♀ (AMNH). Aragua: El Limon, 450 m, 6.VII.1966, J. R. Dedordy, 1 ♀ (UCV); Rancho Grande, Portachuelo, 1100 m, 28.V.1980, J. A. Clavijo, 1 ♂ (UCV).

Anastrepha bezzii Lima

(Figs. 2A, B, 5, 6, 7C, D, 8A, B, 10B, 13B, 14B)

Anastrepha Bezzii Lima 1934: 498 (description, ♂ genitalia; Brazil), 555 (in key); Lima 1937: 63 (description of ♀; Brazil).

Anastrepha bezzii; Stone 1942: 12 (in key), 20; Foote 1967: 8 (in catalog); Steyskal 1977: 7 (in key); Zucchi 1978: 17 (in key), 33; Zucchi 1984: 561 (♀ terminalia; Brazil).

Anastrepha balloui Stone 1942: 12 (in key), 20 (description, ♀ terminalia; Venezuela, Panama); Fernandez 1953: 12 (in key), 17 (host; Venezuela); Guagliumi 1966: 193, 197, 232 (hosts); Foote 1967: 7 (in catalog); Korytkowski and Ojeda 1968: 43 (♂ terminalia), 1969: 79 (Peru); Steyskal 1977: 7 (in key); Caraballo 1981: 30 (in key), 41 (taxonomy, hosts; Venezuela); Aluja et al. 1987 (Mexico); Jiron et al. 1988: 132 (Costa Rica); Norrbom and Kim 1988b: 13 (hosts). NEW SYNONYMY.

Type data.—*bezzii*: holotype ♂ (Instituto Oswaldo Cruz, no. 1796), “Brazil, Rio de Janeiro, Manguinhos, 24.II.1902.” Zucchi (1978) reexamined it and reported its date



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Fig. 6. Distribution of *A. bezzii* (dots = examined specimens; squares = literature records).

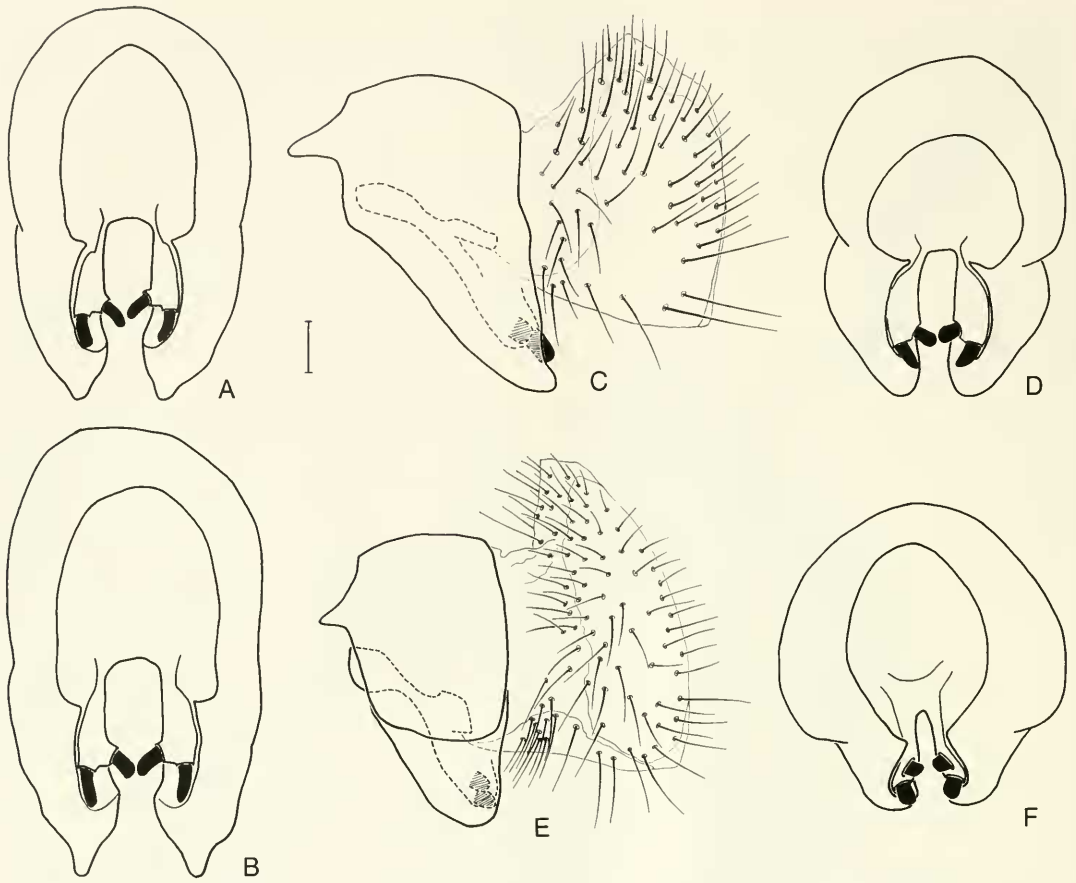


Fig. 7. A, B, *A. atrigona*. C, D, *A. bezzii*. E, F, *A. castilloi*. A, B, D, F, epandrium and surstyli (posterior view). C, E, epandrium, surstyli, and proctiger (lateral view). Bar = 0.1 mm.

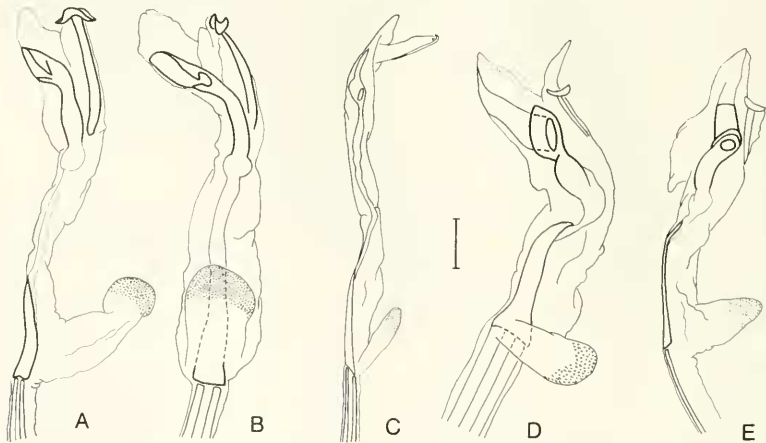


Fig. 8. Distiphallus (lateral view except B, ventral). A, B, *A. bezzii*. C, *A. castilloi*. D, *A. grandis*. E, *A. shannoni*. Bar = 0.1 mm.



Fig. 9. Distributions of *A. castilloi* (dot), *A. grandicula* (square), and *A. shannoni* (triangles); solid figures = examined specimens; hollow = literature records.

of collection as 24.III.1917. Lima dissected and mounted the abdomen and a wing on slides 1876 and 1877. *balloui*: holotype ♀ (USNM), "Venezuela: San Juan de los Morros, on Terminalia catappa, 12.IV.1938, C. H. Ballou." It bears a label with "S. J. los Morros, Venez, 249 C. H. Ballou, 4-12-1938" and "on Terminalia catappa," a red "Type No. 51652 U.S.N.M." label, and a Stone determination label with "Anastre-

pha balloui Stone." Stone dissected and mounted the terminalia on slide 39.IV.17^a.

Description.—Mostly yellowish to orange. Setae redbrown to dark redbrown. *Head*: Concolorous except dark brown ocellar tubercle; 2–4 frontal setae; 1 (rarely 2) orbital seta (posterior seta present, only on left side, in only 1 of 38 specimens examined). Antenna extends 0.50 distance to lower facial margin. *Thorax*: Mesonotum

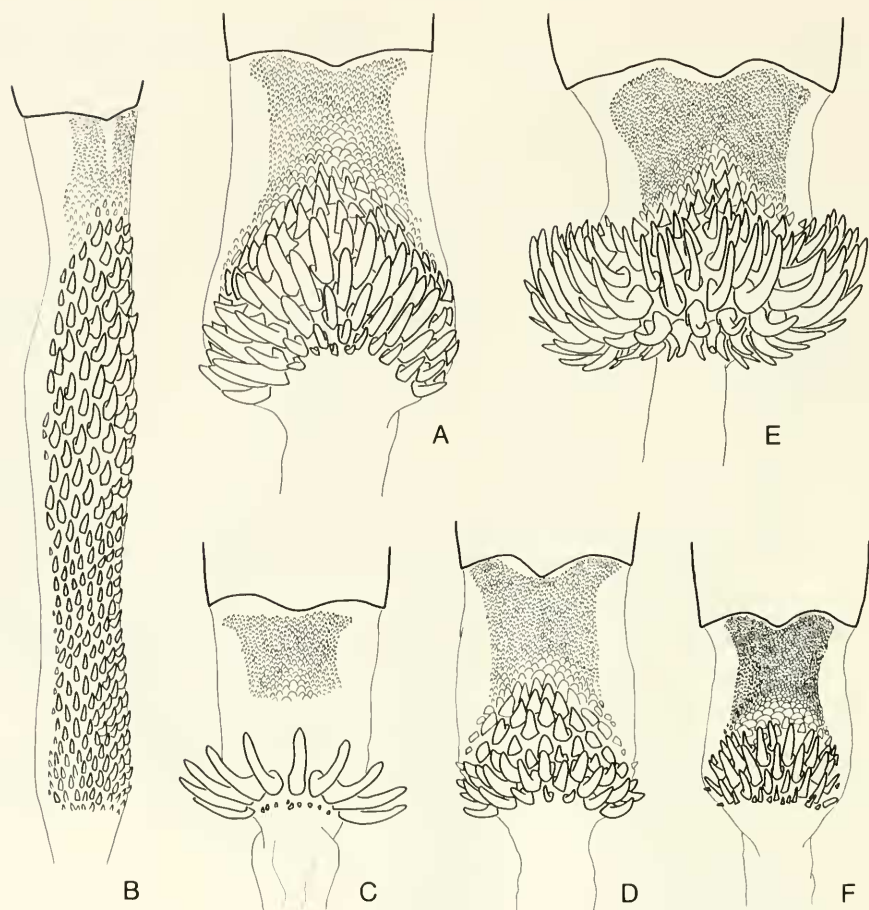


Fig. 10. Dorsal scales of eversible membrane. A, *A. atrigona*. B, *A. bezzii* (redrawn from Stone 1942, at slight lateral view). C, *A. castilloi*. D, *A. grandicula*. E, *A. grandis*. F, *A. shannoni*.

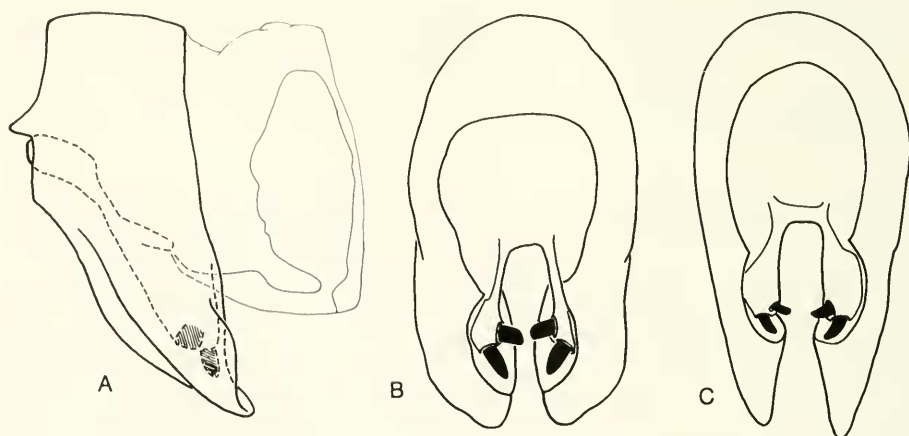


Fig. 11. A, B, *A. grandis*. C, *A. shannoni*. A, epandrium, surstyli, and proctiger (lateral view). B, C, epandrium and surstyli (posterior view).



Fig. 12. Distribution of *A. grandis* (dots = examined specimens; squares = literature records).

3.66–4.52 mm long (up to 5.00 in Brazil (Zucchi 1984)). Scutum entirely microtrichose; mostly yellowish to orange with indistinct whitish or translucent areas; pattern difficult to see, similar to Fig. 3B, but translucent medial stripe hardly expanded until about halfway between transverse suture and posterior margin, and then abruptly so; posterior part of medial stripe larger and more rectangular than in *castilloi*, fusing with narrow translucent stripe extending from an-

terior margin in line with dorsocentral seta; scuto-scutellar suture without distinct medial dark brown spot. Subscutellum and mediotergite entirely yellow to orange. Pleura with typical dark areas poorly differentiated. Katepisternal seta undifferentiated or weak, yellowish, no longer than postocellar seta. *Wing* (Fig. 2A, B): Length 8.39–10.29 mm (up to 10.75 in Brazil (Lima (1937))). Vein R_{2+3} almost straight to strongly undulant. Vein M strongly curved apically,

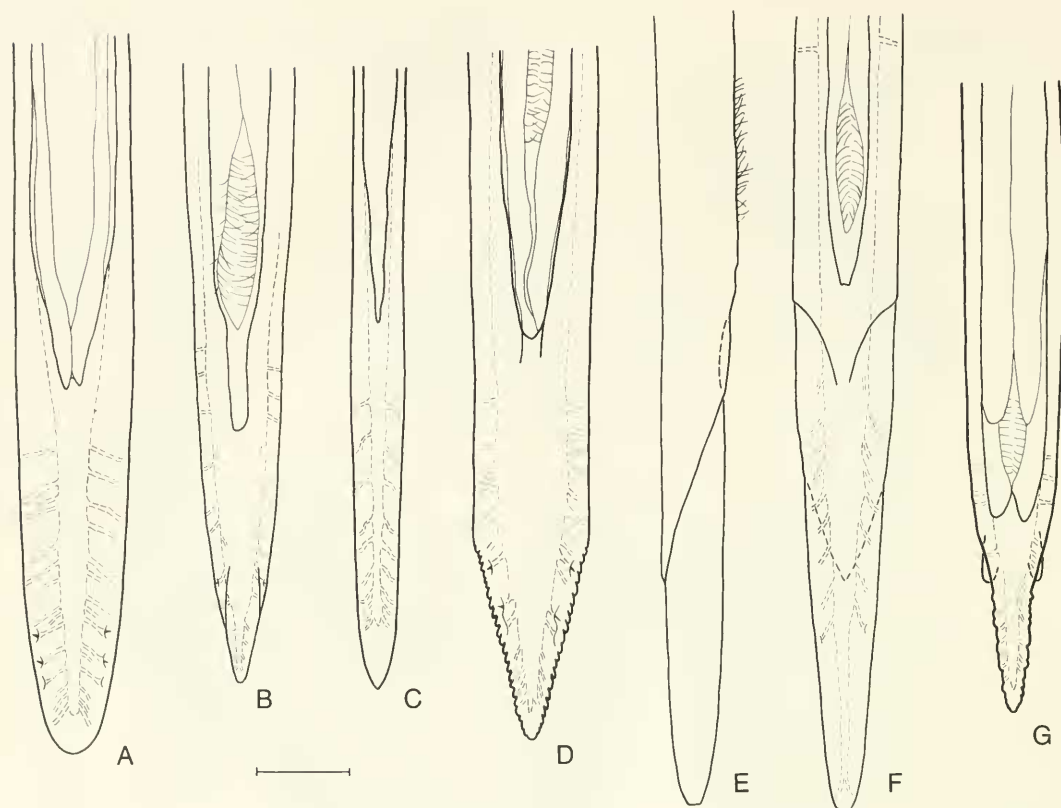


Fig. 13. Aculeus tip (ventral view except E, lateral). A, *A. atrigona*. B, *A. bezzii*. C, *A. castilloi*. D, *A. grandicula*. E, F, *A. grandis*. G, *A. shannoni*. Bar = 0.10 mm.

reaching apex of S-band; section between bm-cu and r-m 1.48–1.79 times as long as section between r-m and dm-cu. Pattern faint yellow to faint orange brown, its margins often diffuse. Cells dm, br and r_{2+3} crossed by hyaline area between bm-cu and r-m, rarely narrowly entering cell r_1 . Cell r_{2+3} also with large subapical hyaline area. Cell bm hyaline. Proximal arm of V-band strong until vein M, usually extending faintly to R_{4+5} ; separate from S-band. *Abdomen*: Tergites unicolorous yellowish to orange. *Male terminalia*: Outer surstylus (Fig. 7D) strongly delimited from epandrium, broad basally, gradually tapering to rounded apex; relatively short, section apical to apex of inner surstylus 0.60–0.70 times as long as basal part; posterior side slightly concave (Fig. 7C). Proctiger (Fig. 7C) without dis-

tinct lateral fold; sclerotized part undivided. Aedeagus 9.71–12.10 mm long; 2.56–2.83 times as long as mesonotum. Distiphallus (Fig. 8A, B) 0.65–0.80 mm long, relatively stout; endophallic sclerite strong, moderately broad, but not distinctly convoluted apically, a subapical hooklike structure usually apparent. *Female terminalia*: Syntergosternite 7 6.28–9.55 mm long (as short as 5.56 mm in Venezuela (Caraballo 1981), up to 12.50 mm in Brazil (Lima 1937)); 1.63–2.16 times as long as mesonotum (up to 2.63 times in Brazil (Lima 1937)). Eversible membrane (Fig. 10B) with dorsobasal scales in elongate pattern 1.85–3.33 mm long (up to 4.00 in Brazil (Zucchi 1984)); largest scales at basal third, 0.08–0.09 mm long. Aculeus 5.62–9.13 mm long (up to 10.00 in Brazil (Zucchi 1984)); tip (Fig. 13B) 0.25–0.35 mm

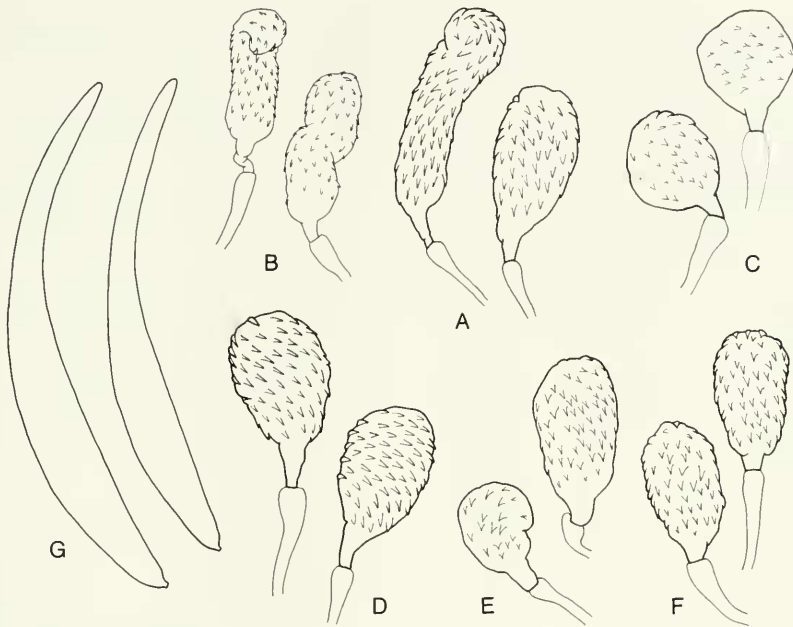


Fig. 14. A-F, spermathecae (2 of 3 shown). G, eggs. A, *A. atrigona*. B, *A. bezzii*. C, *A. castilloi*. D, *A. grandicula*. E, *A. grandis*. F, G, *A. shannoni*.

long, 0.09–0.10 mm wide, non-serrate, sides slightly convex, ventral surface transversely concave with apical $\frac{1}{2}$ slightly convex. Spermathecae (Fig. 14B) weakly sclerotized, elongate ovoid.

Remarks.—There is considerable variation in terminalia length among specimens that are recognized here as *bezzii* (Table 1, Fig. 5). Stone (1942) and subsequent authors recognized populations from Mexico to Venezuela and Peru as a distinct species, *A. balloui*, because they have syntergosternite 7, the aculeus, the part of the eversible

membrane with dorsal scales (the “rasper” of Stone 1942), and the aedeagus shorter than in the few Brazilian specimens previously known. The lengths of all of these structures are correlated, however, and these differences are all the result of variation in terminalia length. The distinctive shape of the aculeus tip, the pattern of the scales of the eversible membrane, the shape of the surstyli, and the wing pattern and venation are consistent in the Brazilian and non-Brazilian specimens.

Table 1 and Fig. 5 present an analysis of

Table 1. *Anastrepha bezzii*: mesonotum length (in mm), syntergosternite 7 length (in mm), and their ratio in specimens from Mexico–Panama, Venezuela, and Brazil.

	Mexico–Panama (n = 10)	Venezuela (n = 8)	Brazil (n = 6)
Mesonotum length	3.66–4.53	3.70–4.48	4.08–5.00
Mean and std. dev.	4.09 ± 0.33	3.99 ± 0.23	4.54 ± 0.32
Syntergost. 7 ln.	6.67–8.48	6.28–7.30	8.07–10.00
Mean and std. dev.	7.76 ± 0.69	6.70 ± 0.29	9.09 ± 0.72
Synt. 7/meson. ln.	1.80–1.96	1.63–1.75	1.90–2.17
Mean and std. dev.	1.90 ± 0.05	1.68 ± 0.04	2.01 ± 0.09

the variation in the length and relative length (ratio to mesonotum length) of syntergosternite 7 between samples from Mexico-Panama, Venezuela, and Brazil. All measurements were taken from examined specimens with the addition of those for single females from Viçosa, Brazil (Zucchi 1984) and Venezuela (Caraballo 1981). The measurements of the female reported by Lima (1937) from Campinas, Goiás, Brazil, which unfortunately has been lost (Zucchi 1984), are plotted for comparison, but are not included in the analysis. Caraballo (1981) found greater variation in syntergosternite 7 length in a larger sample of females from Venezuela (5.56–7.30 mm; $n = 75$). She did not report the relative length, but her range of mesonotal lengths suggests that it is consistent with that in the specimens I examined.

Syntergosternite 7 length and relative length are significantly different (t test, $P < 0.01$) between all samples, as is the arcsine transformation of the inverse of the latter ratio. Mesonotum length is significantly different between Brazil and Venezuela ($P < 0.01$) and Brazil and Mexico-Panama ($P < 0.02$), but not between Venezuela and Mexico-Panama. Thus, although the Brazilian females have longer terminalia, their relative terminalia length is closer to that of the Mexico-Panama sample than to that of the Venezuela sample or the Campinas, Brazil female of Lima (1937) (Fig. 5B). Similarly, the regression lines for these two samples are closer than that for the Venezuela sample (Fig. 5A). There does not appear to be an allometric relationship, at least within samples (Fig. 5B).

I have not examined the male holotype of *bezzii* which is assumed to be conspecific with the Viçosa sample. The type locality of Rio de Janeiro is much closer to Viçosa than to Campinas. At least the Mexico-Panama populations seem to be conspecific, and although the relative terminalia length of the Venezuelan sample is significantly different statistically, whether there is any bi-

ological significance is questionable. The status of the Campinas female is less certain since Lima's measurements cannot be verified, but if they are accurate, it is at least as different from the other Brazilian specimens as the Venezuela population.

I do not believe there is enough evidence at the present time to justify the recognition of the Venezuelan population as a distinct species, and I therefore regard *balloui* Stone a synonym of *bezzii*. Continued use of this name is not justifiable without also regarding the Campinas female as representative of another separate species. Unless other characters or behavioral or biological studies demonstrate otherwise, I believe that all of these specimens should be considered conspecific. Additional collecting, an analysis of larger sample sizes, and biochemical or behavioral studies to test the statistical and biological significance of the differences among them would certainly be useful.

The scutal color pattern in *bezzii* is faint and difficult to see. It was obscured by underlying tissues in most of the specimens I examined, most of which were preserved in fluid prior to pinning.

Biology.—The only well confirmed hosts are *Sterculia apetala* (Jacq.) Karst. (Caraballo 1981) and *S. chicha* St. Hil. (R. A. Zucchi, pers. comm.), although Guagliumi (1966) also listed *Terminalia catappa* L. as a host. The latter record may be erroneously based on Stone's (1942) report that some of the types of *balloui* were collected "on" *T. catappa*, but Guagliumi's listing (p. 232) of two *Opius* species as "Parassita di *Anastrepha balloui* Stone s/*Terminalia*" suggests that he may have seen reared specimens. The larvae reared from *S. chicha* in Brazil fed inside the seed rather than in the pulp of the fruit (R. A. Zucchi, pers. comm.).

Distribution.—Southern Brazil, Peru and Venezuela to Mexico (Fig. 7).

Specimens examined.—Holotype of *balloui* (see Type data). BRAZIL: Minas Gerais: Viçosa, "ex. *Sterculia chicha* (seed)," 20.VII.1987, G. P. Santos, 5 ♂ 5 ♀ (USNM).

COSTA RICA: Alajuela: Orotina, L. F. Jiron, 1 ♀ (UCRSJ). Puntarenas: Lepanto, 8.I.1986, L. F. Jiron & J. Soto, 1 ♂ (USNM). GUATEMALA: Guazacapan, Sta. Rosa, XI.1986, E. Muñiz, 1 ♀ (USNM). MEXICO: Chiapas: Soconusco Region, 1 ♂ 1 ♀ (PMMT); Soconusco Region, I.1984, M. Aluja, 1 ♂ (USNM). PANAMA: Barro Colorado Isld., V-VI.1943, J. Zetek, 1 ♂ 1 ♀ (USNM); same, 4.III.1967, R. D. Akre, 1 ♀ (WSU); Arraijan, III.1950, 1951, J. Zetek, 1 ♂ 1 ♀ (USNM); El Cermeño, various dates I, VI, VI-VII, IX-X.1939-1942, J. Zetek, 6 ♂ 3 ♀ 1 ♀ paratype (USNM) 1 ♀ (NMW). VENEZUELA: Aragua: Gonzalito, 3.II.1950, F. Fernandez-Yepey, 1 ♀ (BMNH); El Limon, 450 m, 5.VIII.1981, G. Yepez, 1 ♀ (UCV); Maracay, 17.VII.1945, F. Fernandez-Yepey, 1 ♀ (CUI). Guárico: San Juan de los Morros, "on *Terminalia catappa*," 12-28.IV.1938, C. H. Ballou, 6 ♂ 3 ♀ paratypes (USNM) 1 ♂ 1 ♀ paratypes (BMNH) 1 ♂ paratype (NMW).

Anastrepha castilloi Norrbom,

NEW SPECIES

(Figs. 2F, 3B, 7E, F, 8C, 9, 10C, 13C, 14C)

Type data.—Holotype ♀ (UCV), VENEZUELA: Bolivar: Auyan-tepui, campamento A, 5°44.8'N, 62°29.5'W, 2200 m, 10-13.II.1988, L. J. Joly & A. Chacon. I have dissected the terminalia which are now stored in a microvial. Paratypes: same data as holotype, 7 ♂ 1 ♀ (UCV), 4 ♂ 2 ♀ (USNM).

Description.—Mostly orange to dark brown. Setae dark redbrown to black. *Head*: Concolorous except dark brown ocellar tubercle; 4-6 frontal setae; 2 orbital setae, posterior one strong. Antenna extends 0.75-0.86 distance to lower facial margin. *Thorax*: Mesonotum (Fig. 3B) 3.33-4.20 mm long. Scutum entirely microtrichose; mostly moderate to dark brown; single distinct yellowish medial stripe from anterior margin to slightly posterior to acrostichal seta, broadly expanded and rounded (not rectangular) posteriorly, extending laterally to

or almost to dorsocentral seta, fusing with narrow, faint orange stripe extending from anterior margin to dorsocentral seta; distinct yellowish sublateral stripe from transverse suture to posterior margin, crossing intra-alar seta; distinct yellowish mark extending posteriorly from postpronotal lobe to presutural supra-alar seta, almost joining sublateral stripe on transverse suture; scuto-scutellar suture without distinct medial dark brown spot. Subscutellum and mediotergite light brown, broadly dark brown laterally. Pleura with typical dark areas weakly to moderately differentiated except spots on laterotergite and metapleuron dark brown; greater ampulla mostly dark brown. Katepisternal seta weak, orange, smaller than postocellar seta. *Wing* (Fig. 2F): Length 7.65-9.22 mm. Vein R_{2+3} almost straight. Vein M weakly to moderately curved apically; section between bm-cu and r-m 1.96-2.34 times as long as section between r-m and dm-cu. Pattern orange brown, its margins distinct. Cell r_{2+3} with large subapical hyaline area; entirely infuscated basally. Cell br with large hyaline spot apical to dm-cu, extending more than halfway to r-m. Cell dm with large basal hyaline spot. Cell bm hyaline. Proximal arm of V-band ends at M, broadly separated from S-band. *Abdomen*: Tergites unicolorous yellowish to light brown. *Male terminalia*: Outer surstylus (Fig. 7F) rapidly tapering basally, blunt apically; short, section apical to apex of inner surstylus 0.45-0.55 times as long as basal section; in lateral view (Fig. 7E), posterior margin almost straight. Proctiger (Fig. 7E) setose dorsally, with distinct lateral fold; sclerotized part narrowly divided into 3 sections. Aedeagus 5.47-5.95 mm long; 1.33-1.54 times as long as mesonotum. Distiphallus (Fig. 8C) 0.59-0.71 mm long, slender; endophallic sclerite weakly sclerotized and slender, but similar in shape to *grandis*, stout and distinctly convoluted apically. *Female terminalia*: Syntergosternite 7 4.49-4.95 mm long; 1.21-1.35 times as long as mesonotum. Eversible membrane (Fig. 10C)

with dorsobasal scales minute except 10–11 large hooklike scales in single row, separated from minute scales by membranous area; largest scales 0.25 mm long. Aculeus 3.95–4.53 mm long; shaft 0.05–0.06 mm wide at midpoint, sides parallel; tip (Fig. 13C) 0.40–0.43 mm long, 0.05–0.06 mm wide, non-serrate, sides slightly convex. Spermathecae (Fig. 14C) globose.

Distribution (Fig. 9).—Known only from the type locality.

Etymology.—At the suggestion of one of the collectors of the type series, Prof. Luis Joly, this species is named for Dr. Carlos Castillo, an enthusiastic conservationist and the President of Maraven, the company which organized the expedition to Auyan-tepui.

Anastrepha grandicula Norrbom,

NEW SPECIES

(Figs. 2D, 9, 10D, 13D, 14D)

Type data.—Holotype ♀ (FSCA), COLOMBIA: Amazonas: Rio Putumayo, Puerto Arica, 8.VII.1978, M. A. Tidwell. I have slide mounted the right wing and dissected the abdomen which is now stored in a microvial.

Description.—Mostly orange brown. Setae dark redbrown to black. *Head*: Concolorous except dark brown ocellar tubercle; 3 frontal setae; 2 orbital setae, posterior one weak. Antenna extends 0.65 distance to lower facial margin. *Thorax*: Mesonotum 3.74 mm long. Scutum entirely microtrichose; mostly orange brown; pattern similar to Fig. 3A, single distinct yellowish medial stripe from anterior margin to slightly posterior to acrostichal seta, slightly expanded posteriorly but not extending laterally beyond acrostichal seta; no narrow yellowish stripe in line with dorsocentral seta or dark brown stripe slightly lateral to dorsocentral seta; distinct yellowish sublateral stripe from transverse suture to posterior margin, crossing intra-alar seta; scuto-scutellar suture without distinct medial dark brown spot. Subscutellum and mediotergite orange

brown, broadly dark brown laterally. Pleura with typical dark areas weakly differentiated. Katepisternal seta weak, yellowish, subequal to postocellar seta. *Wing* (Fig. 2D): Length 7.98 mm. Vein R_{2+3} almost straight. Vein M strongly curved apically; section between bm-cu and r-m 2.29 times as long as section between r-m and dm-cu. Pattern orange brown, its margins distinct. Cell r_{2+3} with large subapical hyaline area; entirely infuscated basally. Cell br with large hyaline spot apical to dm-cu, extending more than halfway to r-m. Cell dm with large basal hyaline spot. Cell bm hyaline. Proximal arm of V-band extends anteriorly to R_{4+5} , but not joined to S-band. *Abdomen*: Tergites unicolorous yellowish. *Female terminalia*: Syntergosternite 7 3.62 mm long; 0.97 times as long as mesonotum. Eversible membrane (Fig. 10D) with dorsobasal scales in triangular pattern; 8 large hooklike scales in broadest row; largest scales 0.20 mm long. Aculeus 3.29 mm long; shaft 0.14 mm wide at midpoint, sides parallel; tip (Fig. 13D) 0.41 mm long, 0.14 mm wide, apical half serrate, sides very slightly concave in basal half, evenly tapering, straight in apical half. Spermathecae (Fig. 14D) ovoid.

Distribution (Fig. 9).—Known only from the type locality.

Etymology.—The epithet, which means “rather large” in Latin, was selected because of the similarity of this species with *grandis* and its slightly smaller female terminalia.

Anastrepha grandis (Macquart)

(Figs. 2E, 3C, 8D, 10E, 11A, B,
12, 13E, F, 14E)

Tephritis grandis Macquart 1846: 340 (description; Colombia or Venezuela).

Trypeta (Acrotoxa) grandis; Loew 1873: 231.

Anastrepha grandis; Bezzi 1909: 284 (type data), 286 (in key); Hendel 1914a: 69, 1914b: 14 (in key), 15 (in catalog); Bezzi 1919a: 4 (in key), 6 (description; Paraguay, Brazil); Bezzi 1919b: 374; Lima 1930: 21 (hosts; Brazil); Fischer 1932: 302 (description, host, larva; Brazil), 1934: 18

(description, hosts; Brazil); Lima 1934: 496 (♂ terminalia, hosts; Brazil), 555 (in key); Greene 1934: 132, 138 (in keys), 145 (hosts; Paraguay, Brazil; see also *shannoni*); Blanchard 1937: 41 (Argentina); Stone 1942: 12 (in key), 22 (♀ terminalia, hosts; Panama); Fernandez 1953: 12 (in key), 19; Blanchard 1961: 288 (in key), 297 (Argentina); Foote 1967: 11 (in catalog); Korytkowski and Ojeda 1968: 37 (hosts), 43, 1969: 78–79 (Peru); Steyskal 1977: 7 (in key); Zucchi 1978: 17 (in key), 56 (Brazil); Malavasi et al. 1980: 11 (host; Brazil); Caraballo 1981: 30 (in key), 46 (description, hosts; Venezuela); Boscán et al. 1980: 55 (host; Venezuela); Norrbom and Kim 1988b: 28 (hosts); Steck and Wharton 1988: 999 (larvae, egg); Nascimento et al. 1988: 54 (biology).

Anastrepha schineri Hendel 1914a: 69 (Bolivia), 1914b: 15 (in key), 16 (in catalog), 19 (description again as n. sp.); Fischer 1932: 303 (synonymy); Greene 1934: 145; Stone 1942: 23; Foote 1967: 11; Korytkowski and Ojeda 1968: 43; Zucchi 1978: 56.

Anastrepha latifasciata Hering: 1935: 227 (description; Brazil); Lima 1937: 63 (synonymy); Stone 1942: 23; Foote 1967: 11; Korytkowski and Ojeda 1968: 43; Zucchi 1978: 56.

Type data.—*T. grandis*: Lectotype (here designated) ♀ (UMO), “De la Nouvelle-Grenade. Collection de M. Bigot.” The lectotype was the only putative syntype of *T. grandis* I found in the exotic cabinet of the Bigot Collection (UMO). It bears a label with “*Tephritis grandis* n. sp.” in Macquart’s writing and “♀, Nov. Granata, Macq. D. Exot. nom.” in Bigot’s writing. It is missing both wings, but is clearly recognizable as this species by its body color and terminalia, especially the tip of the aculeus, which is slightly projecting as is common in this species and as is shown in Macquart’s illustration (tab. 18, fig. 14). Nueva Granada was the Spanish colony including Co-

lombia and Venezuela. *A. schineri*: Holotype ♂ (TMB), “aus Bolivia, Coroico.” It has a label with “Bolivia Coroico,” a label with “*Anastrepha schineri* H. typus det. Hendel” in Hendel’s writing, and an orange bordered “typus” label. *A. latifasciata*: Holotype ♀ (PAN), “von Sta. Catharina, Sammler Lüderwaldt.” The type locality is the state or perhaps the island of Santa Catarina, Brazil. The holotype has the following labels: “S. Catarina, Lüderwaldt” (green), “Type” (orange), “*Anastrepha* ♀ det. Dr. Enderlein,” and “*Anastrepha latifasciata* m. Type, det. M. Hering 1935.” I added holotype and determination labels.

Description.—Mostly orange to red-brown. Setae usually moderate redbrown. *Head*: Concolorous except dark brown ocellar tubercle; 3–5 frontal setae; 1–2 orbital setae, posterior one often weak when present. Antenna extends 0.60–0.72 distance to lower facial margin. *Thorax*: Mesonotum (Fig. 3C) 2.88–4.22 mm long. Scutum entirely microtrichose; mostly orange to red-brown; single distinct yellowish medial stripe from anterior margin to slightly posterior to acrostichal seta, moderately expanded posteriorly, extending laterally beyond acrostichal seta but not reaching dorsocentral seta; no narrow yellowish stripe in line with dorsocentral seta, but dark brown, sometimes poorly differentiated stripe slightly lateral to dorsocentral seta; distinct yellowish sublateral stripe from transverse suture to posterior margin, crossing intralar seta; scuto-scutellar suture usually with irregular medial dark brown spot. Subscutellum and mediotergite orange brown, broadly dark brown to black laterally. Pleura with typical dark areas weakly differentiated except anepimeron usually with dark brown spot. Katepisternal seta undifferentiated or weak, yellowish, no longer than postocellar seta. *Wing* (Fig. 2E): Length 7.95–10.30 mm. Vein R_{2+3} almost straight. Vein M moderately curved apically; section between bm-cu and r-m 2.18–2.69 times as long as section between r-m and dm-cu. Pat-

tern faint yellow brown to orange brown, its margins often diffuse. Cell r_{2+3} entirely infuscated. Cell br with large hyaline area apical to bm-cu, extending more than halfway to r-m. Cell dm with large basal hyaline area. Cell bm hyaline. Proximal arm of V-band ending at M or extending anteriorly, often faintly, to R_{4+5} to fuse with S-band. *Abdomen*: Tergites unicolorous yellowish to orange. *Male terminalia*: Outer surstylus (Fig. 11B) broad basally, tapering apically to short blunt lobe; moderately long, section apical to apex of inner surstylus 0.95–1.33 times as long as basal section; posterior side distinctly concave (Fig. 11A). Proctiger with distinct lateral fold; sclerotized part narrowly divided into 3 sections or only weakly connected (Fig. 11A). Aedeagus 6.70–7.40 mm long; 1.70–2.33 times as long as mesonotum. Distiphallus (Fig. 8D) 0.55–0.68 mm long, relatively stout; endophallic sclerite strong, stout and distinctly convoluted apically. *Female terminalia*: Syntergosternite 7 4.99–6.28 mm long; 1.40–1.59 times as long as mesonotum. Eversible membrane (Fig. 10E) with dorsobasal scales in broad subtriangular pattern; 14–16 large hooklike scales in broadest row; largest scales 0.30 mm long. Aculeus 5.27–6.18 mm long, often as long or longer than syntergosternite 7; tip (Fig. 13E, F) 0.58–0.66 mm long, 0.16–0.18 mm wide, non-serrate, sides slightly convex, ventral surface with V-shaped ridge subbasally, dorsal surface with V-shaped ridge at midlength. Spermathecae (Fig. 14E) ovoid to elongate ovoid.

Remarks.—The aculeus was broken in the female with the shortest syntergosternite 7 and was probably no more than 5.00 mm long.

Distribution (Fig. 12).—Southern Brazil, northern Argentina, Paraguay, and along the Andean Cordillera from Bolivia to Venezuela. Apparently *grandis* does not occur in the Guianas, Amazonia, and northeastern Brazil. In the latter country it has been collected in Bahia (Bondar 1950; exact locality not reported and not shown in Fig. 12), Mato

Grosso, and Goiás (Zucchi 1988), but it has not been detected north of these states, including in Rio Grande do Norte, where an extensive monitoring program has been operating since 1986 (Nascimento et al. 1988, A. Malavasi, pers. comm.). In Bolivia and northward, *grandis* appears restricted to lower elevations of the Andes and bordering areas. It has not been detected in the lowland coastal melon-growing region of Ecuador (Harper 1987). The record from Panama (Stone 1942) is questionable. The single female in the USNM on which it was probably based was intercepted from a plane or ship from Panama, but it is not certain that the cargo in which it was found originated in that country.

Biology.—The only normal hosts native to the Neotropics are *Cucurbita pepo* L., *C. moschata* (Duchesne) Poiret, and *C. maxima* Duchesne (Fischer 1932, Malavasi et al. 1980, Caraballo 1981, Boscán et al. 1980). In addition, *grandis* has been reported to attack introduced cucurbits such as watermelon (*Citrullus lanatus* var. *lanatus* (Thunb.) Matsum. & Nakai) (Lima 1934, Stone 1942), melon (*Cucumis melo* L.) (Korytkowski & Ojeda 1968), cucumber (*Cucumis sativus* L.) (Lima 1934, Stone 1942), and calabash gourd (*Lagenaria siceraria* (Mol.) Standl.) (Caraballo 1981). Fischer (1934) reared one specimen from a guava fruit, but considered it an abnormal record because the fruit came from a tree in the middle of a field planted with *Cucurbita*. Despite the comments of Korytkowski and Ojeda (1969), records from *Citrus* are doubtful. Host records are summarized by Norrbom and Kim (1988b). Nascimento et al. (1988) report various biological parameters involving oviposition and duration of life stages based on studies with laboratory cultures in São Paulo.

Specimens examined.—Lectotype of *grandis*; holotypes of *latifasciata* and *schineri* (see Type data). ARGENTINA: Misiones: Montecarlo, 4.VI.1982, G. Putruele, 3 ♂ 2 ♀ (INTA) 1 ♂ 1 ♀ (USNM). BOLIVIA:

Mapiri, Sarampioni, 700 m, 1.III.1903, 1 ♂ (SMT); Sucre, 17.VI.1966, J. C. Ballard, 1 ♀ (USU); Yungas von Coroico, 1800 m, 7.XII.1906, 1 ♀ (SMT). BRAZIL: Espirito Santo: Espirito Santo, Fruhstorfer, 1 ♂ (DEI). Goiás: Anápolis, various dates V–VII, XI.1936, G. Fairchild, 4 ♂ (MCZ) 2 ♂ (USNM); 24 km E Formoso, 25.V.1956, F. S. Truxal, 2 ♀ (LACM). Mato Grosso: Campo Grande, X.1947, A. Maller, 1 ♂ 1 ♀ (USNM); Chapada [probably Chapada dos Guimarães], XI, 1 ♂ (AMNH); Maracaju, V.1937, 2 ♂ 2 ♀ (USNM). Minas Gerais: Viçosa, "reared from squash," XI.1928, M. Kisliuk & C. E. Cooley, 1 ♂ 2 ♀ (USNM). Parana: Rolândia (Caviuna), II, III, V–VII, X.1946–1947, A. Maller, 5 ♂ 6 ♀ (AMNH) 1 ♂ 1 ♀ (USNM). Rio de Janeiro: Nilopolis, 18.XI.1931, M. Kisliuk & C. E. Cooley, 1 ♂ (NMW) 1 ♀ (USNM); Nova Iguaçu, 16.XI.1931, M. Kisliuk & C. E. Cooley, 1 ♀ (NMW); Rio de Janeiro, "bred in fruits of Cucurbitaceae," 1927, 2 ♂ 2 ♀ (MCZ); Rio de Janeiro, reared ex watermelon, P. 22.XI, Em. 11.XII.1931, M. Kisliuk & C. E. Cooley, 2 ♂ 3 ♀ (USNM); Tinguá, III.1940, R. C. Shannon, 1 ♀ (USNM). Rio Grande do Sul, VII.1930, M. Kisliuk & C. E. Cooley, 1 specimen without abdomen (USNM). Santa Catarina: Corupa (Hansa Humboldt), various dates I, VI, VIII.1946, A. Maller, 2 ♂ 1 ♀ (AMNH) 1 ♀ (USNM); Nova Teutonia, various dates, all months, various years 1936–1973, F. Plaumann, 6 ♂ 22 ♀ (CNC) 6 ♂ 6 ♀ (USNM) 2 ♂ 4 ♀ (AMNH) 1 ♂ 3 ♀ (MCZ) 2 ♂ 1 ♀ (BMNH) 2 ♂ 2 ♀ (FMNH). São Paulo: Sto. Amaro, "larva colhida de abobora, crysal. 24.IV.1933, eclosao 5.VI.1933," Fischer, 1 ♂ 2 ♀ (DEI); São Paulo, 26.XII.1931, M. Kisliuk & C. E. Cooley, 1 ♂ (USNM); Univ. São Paulo, laboratory culture of A. Malavasi, reared ex "pumpkin," XI.1986, G. J. Steck, 1 ♂ 1 ♀ (USNM). COLOMBIA: Antioquia: Santa Barbara, 5.II.1988, A. Bustillo, 1 ♀ (USNM). Boyacá: Muzo, 900 m, J. Bequaert, 1 ♂ (MCZ). Cauca: Santander, 26.I.1989, A. Trochez, 1 ♂ 1 ♀ (USNM).

Santander: Bucaramango, 20.XII.1988, A. Trochez, 1 ♂ 1 ♀ (USNM). Valle: Florida, 18.IV.1988, A. Trochez, 1 ♀ (USNM). EC-UADOR: Loja: Malacatos, 26.XII.1980, C. Pacheco, 1 ♀ (USNM). PANAMA, intercepted at San Francisco, California, 18.III.1937, 1 ♀ (USNM). PARAGUAY: Alto Parana: Hohenañ, IV.1938, F. Schade, 1 ♂ 1 ♀ (USNM); Bella Vista, VI.1938, F. Schade, 1 ♂ (USNM); Bella Vista, I, 1 ♀ (MCZ). Concepcion: Horqueta, A. Schulze, 1 ♀ (USNM). Guaira: Villarrica, V.1940, F. Schade, 1 ♀ (USNM). La Cordillera: San Bernardino, K. Fiebrig, 1 ♀ (USNM). PERU: Cuzco: Quillabamba, 23–27.XII.1983, L. Huggert, 1 ♀ (ZIL); [Rio] Mishagua–Urubamba fl. [junction], 13.X.1903, 1 ♂ (SMT). VENEZUELA: Aragua: Rancho Grande, 1100 m, 22–24.VI.1984, D. S. Bogar, 1 ♀ (USNM). Carabobo: Las Trincheras, 700 m, 30.III.1981, L. D. Otero, 1 ♂ (UCV).

Anastrepha shannoni Stone

(Figs. 2G, 8E, 9, 10F, 11C, 13G, 14F, G) (part) *Anastrepha grandis*; Greene 1934: 145 (misidentification).

Anastrepha shannoni Stone 1942: 12 (in key), 23 (description, Peru); Foote 1967: 16 (in catalog); Steyskal 1977: 7 (in key). (?) *Anastrepha shannoni*; Korytkowski and Ojeda 1968: 49 (♀ terminalia), 1969: 78 (Peru).

Type data.—Holotype ♂ (USNM). It bears a label with "Chimbotes, Amaz. Peru," a label with "R. C. Shannon Coll. Mar.20.31," a red "Type No. 51653 U.S.N.M." label, and a Stone determination label with "Anastrepha shannoni Stone." Stone dissected and mounted the left wing and abdomen on slides 39.VIII.4b and 39.II.9b, respectively. He reported the type locality as "Chimbotes, Amazonas, Peru," but it is probably the town of Chimbote, at 3°52'S 70°45'W in Loreto Department. The "Amaz." on the label probably refers to the Amazon River, along which this town is located, rather than Amazonas Department.

Description.—Mostly redbrown to dark redbrown. Setae dark redbrown to black. *Head*: Concolorous except dark brown ocellar tubercle; 3–4 frontal setae; 2 orbital setae, posterior one usually weak. Antenna extends 0.70–0.80 distance to lower facial margin. *Thorax*: Mesonotum 3.65–3.90 mm long. Scutum entirely microtrichose; mostly redbrown to dark redbrown; single distinct yellowish medial stripe from anterior margin to slightly posterior to acrostichal seta, moderately expanded posteriorly, extending laterally beyond acrostichal seta but not reaching dorsocentral seta; narrow, faint orange stripe extending from anterior margin, crossing dorsocentral seta; distinct yellowish sublateral stripe from transverse suture to posterior margin, crossing intra-alar seta; distinct yellowish mark extending posteriorly from postpronotal lobe to presutural supra-alar seta, almost joining sublateral stripe on transverse suture; scuto-scutellar suture often entirely dark brown, but without distinct medial spot. Subscutellum and mediotergite narrowly orange medially, broadly redbrown to dark brown laterally. Pleura with typical dark areas of anepisternum, katepisternum, anepimeron, meron, and laterotergite redbrown to dark brown, strongly contrasting with lighter areas. Katepisternal seta undifferentiated or weak, yellowish, no longer than postocellar seta. *Wing* (Fig. 2G): Length 8.10–8.60 mm. Vein R_{2+3} almost straight. Vein M strongly curved apically; section between bm-cu and r-m 2.45–2.90 times as long as section between r-m and dm-cu. Pattern light yellow brown to dark orange brown, its margins often diffuse. Cells br and r_{2+3} entirely infuscated. Cell dm with large basal hyaline area. Cell bm hyaline. Proximal arm of V-band not extending anteriorly beyond M, not connected to S-band. *Abdomen*: Tergites 1–5 with even-sided medial yellowish stripe, lateral third redbrown. *Male terminalia*: Outer surstylus (Fig. 11C) broad basally, gradually tapering to slightly acute apex; elongate, section apical to apex of inner surstylus 1.45–

1.80 times as long as basal section; similar to *grandis* in lateral view. Proctiger with distinct lateral fold; sclerotized part narrowly divided into 3 sections. Aedeagus 4.90 mm long; 1.26 times as long as mesonotum. Distiphallus (Fig. 8E) 0.60–0.62 mm long, relatively stout; endophallic sclerite strong, stout and distinctly convoluted apically. *Female terminalia*: Syntergosternite 7 3.30–3.95 mm long; 0.90–1.03 times as long as mesonotum. Eversible membrane (Fig. 10F) with dorsobasal scales in triangular pattern; 6–7 large hooklike scales in broadest row; largest scales 0.12 mm long. Aculeus 3.00 mm long; shaft 0.13–0.14 mm wide at midpoint, sides parallel; tip (Fig. 13G) 0.23 mm long, 0.09–0.10 mm wide, apical three-fifths serrate, sides slightly concave, dorsal surface with large basal lobe on each side. Spermathecae (Fig. 14F) ovoid. *Egg* (Fig. 14G): Length 1.90–2.02 mm. Broadest diameter 0.22–0.26 mm. Elongate, distinctly curved; slender, especially apical (non-micropyle) half, broadest at basal third.

Remarks.—As noted by Stone (1942), Greene (1934) misidentified the holotype as *grandis*. Korytkowski & Ojeda (1968) described five males and one female from Jayanca, Lambayeque, Peru that they determined as *shannoni*. According to their description and illustrations, the wing pattern and the scutal color pattern of these specimens match those of the holotype except that the yellowish medial scutal stripe is broader posteriorly, extending laterally beyond the dorsocentral seta. The shapes of the aculeus tip, the scales of the eversion membrane, and the surstylus are similar to *A. grandis*, however, differing markedly from those of the holotype and other specimens of *shannoni* described in this paper, and the lengths they reported for syntergosternite 7 (4.58 mm) and the aculeus (4.83 mm) are intermediate between *grandis* and the Venezuelan females of *shannoni*. It is possible that Korytkowski and Ojeda confused the terminalia of these specimens with those of specimens of *grandis*, or these specimens

may represent a different, undescribed species. I was unable to borrow them for more careful study.

The description of the egg is based on several dissected from the abdomen of one of the Venezuelan females. They are extremely similar to the eggs of *grandis* (Steck and Wharton 1988), and those of both species are notable for their large size and slender shape.

Distribution (Fig. 9).—Western Amazonia and southern Venezuela; also western Peru if the specimens reported by Korytkowski and Ojeda (1968) were correctly determined.

Specimens examined.—Holotype (see Type data). BRAZIL: Amazonas: Rio Purus, "Hyutanahan" [= Huitanaã], II.1922, S. M. Klages, 1 ♂ (CMP). VENEZUELA: Bolivar: Caura Val., C. W. Johnson Collection, 1 ♀ (MCZ) 1 ♀ (USNM).

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